has been substantially incorporated into amended claim 1, but changed to clarify that the resonant cavity for the pumping radiation comprises a Nd:YAG sample that is between a pair of members (mirrors) that reflect wavelengths of about 1 μm.

This pumping source and associated resonant cavity appear in Fig. 1 and are described, for example, in the first full paragraph on page 7 of the specification.

Claim 12 (which is amended here to incorporate the subject matter of now-cancelled claim 14) has also been rewritten with the clarifying language just discussed with respect to claim 3. Accordingly, applicant submits that the rejection of claims 3-7 and 14 under Section 112, first paragraph, may be withdrawn.

It is also noted that claims 8 and 19 have been amended to clarify that the Tm:YAG sample (such as shown at 7 in the embodiment of Fig. 1) is between the second pair of members (such as mirrors 8 and 9 in Fig. 1), and amended claim 9 and 20 now clarify that those second members are within the resonant cavity that is composed of the Nd:YAG sample and first pair of spaced-apart mirrors.

Claim Rejections – 35 USC § 112, Second Paragraph

The claim recitations including the phrase "capable of" have been removed from the amended claims. Accordingly, applicant believes the rejection of claims 1 and 12 under Section 112, second paragraph, (paragraph 5 of the Detailed Action) may now be withdrawn.

Claim 1 has been amended to include a resonant cavity and reflective members, thereby obviating the rejection specified on paragraph 6 of the Detailed Action.

The claims have been amended in a way so that every recitation of a "second pair" is in combination with a prior recitation of a "first pair," thereby addressing the rejection specified in paragraph 7 of the Detailed Action.

The rejection grounds of cancelled claim 15 have been considered, and no similar informality is believed to be present in the amended claims.

Rejection of Claims as Anticipated Under 35 USC § 102(b) by Meissner, Jackson, and Zayhowski

Independent claims 1 and 12 of the present application were rejected as anticipated by Meissner, Jackson, and Zayhowski. In reply, it is respectfully submitted that none of these

documents contains a teaching of the pumping of a Tm:YAG laser with an Nd:YAG laser (the Nd:YAG producing a radiation of about 1 μm). [1]

Turning first to Meissner, it can clearly be seen that, for instance, in the table presented in column 11 of this document, the pumping of a sample doped with Tm^{3+} ions takes place with a pump wavelength of 785 nm, which clearly is not produced by a Nd:YAG sample. Nowhere in this document is there any suggestion that a Tm:YAG sample may be pumped with radiation derived from an Nd:YAG laser.

Turning to the disclosure of Zayhowski, while the pumping of the sample using a resonant cavity comprising a Nd:YAG sample is disclosed, there is no disclosure that the material that is pumped comprises a Tm:YAG sample as claimed. This is crucial because, as will be explained below, although Nd:YAG lasers are used for pumping purposes, they have not been used for pumping Tm:YAG samples.

Turning to the article from the journal of Quantum Electronics (by Jackson *et al*), this document includes a reference to a Tm:YAG sample, on page 785 thereof. However, looking at the page in question, it is simply stated that some energy level separations, which are used in the articles, are derived from Tm:YAG. Applicant submits, however, that this does not constitute what one of ordinary skill would fairly consider a disclosure of the use of Tm:YAG as claimed.

In view of the foregoing, applicant submits that claims 1 and 12, and the claims depending therefrom, are not anticipated by the above noted references and the rejection should be withdrawn.

Rejection of Claims as Obvious Under 35 USC § 103(a) in View of the Combination of Meissner and Zayhowski

Claims 3 – 7 and 14 - 18 were rejected as obvious in view of the combination of Meissner and Zayhowski. In reply, applicant notes that a key aspect of the invention is that the applicant is the first to pump successfully a Tm:YAG laser with a 1064 nm Nd:YAG laser. The benefit of this is that the Nd:YAG is a very common and readily available laser system, while the Tm:YAG laser is a very difficult laser to build (and not readily available commercially), conventionally requiring the use of expensive 785-nm diode lasers to pump it.

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[1] Applicant notes that 1 μm is equivalent to 1000 nanometer (nm), thus, the claimed wavelengths of 1 μm, 2 μm, and 1.064 μm respectively correspond to 1000 nm, 2000 nm, and 1064 nm.

Nothing in the art of record contemplates or suggests an attempt to pump a Tm:YAG laser with a 1064 nm Nd:YAG laser. This is because no known or published data existed that supported the possibility of a reasonable absorption of the 1064 nm Nd:YAG laser radiation by the Tm:YAG medium. Applicant submits that experts at the time held the opinion that there is no reasonable absorption of the 1064 nm photons by the Tm:YAG medium and, hence, that to pump a Tm:YAG sample with this 1064 nm light would be regarded as a futile effort. The present inventors have discovered that, although there may not be significant absorption of the 1064 nm light by the Tm:YAG medium, the small absorption that is present is enough to construct an effective Tm:YAG laser, using the intra-resonant-cavity approach to enhance this small absorption.

The Examiner's comments that someone skilled would readily combine the disclosures of Meissner and Zayhowski, to replace the Cr:YAG sample in the Zayhowski document with a Tm:YAG sample is not well-founded, in view of the significant technical prejudice in the art outlined above. A laser expert would know that the key requirement in the designing of a laser is to match the pump wavelength with a reasonably high absorption in the laser medium, and the pump wavelengths and absorption peaks in the lasing materials are all very specific to the particular pumping laser and the lasing material. For example, therefore, the common way laser scientists have pumped the Tm:YAG laser in the past is by using a 785 nm diode laser, specifically because the Tm:YAG medium has been know to have a strong absorption at 785 nm (people, including Meissner, have measured and published this data), and this absorption is only strong over a very narrow wavelength range of around 5 nm. If a diode laser emitting radiation at 790 nm instead of 785 nm was used, the performance of the Tm:YAG laser would be drastically degraded.

Since the measured absorption of Tm:YAG pumped at 1064 nm is negligibly low (such that no figures are even published for the absorption of this wavelength), no expert would think of using 1064 nm radiation to pump a Tm:YAG laser.

In view of the above, and particularly in view of the prevailing technical prejudice in the art, which would have dissuaded a skilled person from contemplating the present invention, it is submitted that the invention is not obvious with respect to the cited prior art.

Conclusion

In view of the foregoing, applicant submits that all of the pending claims are in condition for allowance, and an early notification to that effect is respectfully requested.

If the Examiner has any questions, he is invited to contact applicant's attorney at the telephone number given below.

Respectfully submitted,
ipsolon llp

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Attachment to Amendment

Claims:

1. (Amended) A device for producing laser radiation having a wavelength of about 2μm, the device comprising:

a Tm:YAG ~~solid-state~~ sample ~~capable of producing lasing transitions corresponding to a wavelength of about 2 μm~~; and

a source of pumping radiation having a wavelength of about 1μm, the source of pumping radiation comprising a resonant cavity composed of a Nd:YAG sample and a first pair of members that are substantially reflective to radiation having a wavelength of about 1μm, the Nd:YAG sample being substantially interposed between the first pair of members,

the resonant cavity having the Tm:YAG sample located substantially therein, and the source being arranged so that at least some of the radiation produced thereby is absorbed by the Tm:YAG ~~solid-state~~ sample, causing the Tm:YAG ~~solid-state~~ sample to emit radiation having a wavelength of about 2 μm.

5. (Amended) A device according to Claim 1~~4~~, comprising a source of pumping radiation for the Nd:YAG sample to stimulate the Nd:YAG sample to emit radiation having a wavelength of about 1μm.

8. (Amended) A device according to Claim 1, wherein the ~~solid-state~~ Tm:YAG sample is substantially interposed between a second pair of members, at least one of which is substantially reflective to radiation having a wavelength of about 2μm.

9. (Amended) A device according to Claim 8, wherein the second pair of members is located substantially within the resonant cavity ~~source of radiation having a wavelength of about 1μm~~.

12. (Amended) A method of producing laser radiation having a wavelength of about 2μm, the method comprising the steps of:

providing a ~~solid-state~~ Tm:YAG sample ~~capable of producing lasing transitions corresponding to a wavelength of about 2 μm~~;

providing a resonant cavity, the resonant cavity being composed of a Nd:YAG sample and a first pair of members that are substantially reflective to radiation having a wavelength of about 1μm, the Nd:YAG sample being substantially interposed between the first pair of members;

locating the Tm:YAG sample substantially within the resonant cavity; and

emitting pumping radiation having a wavelength of about 1μm within the resonant cavity so that at least some of the radiation having a wavelength of about 1μm is absorbed by the ~~solid-state~~ Tm:YAG sample, causing the ~~solid-state~~ Tm:YAG sample to emit radiation having a wavelength of about 2μm.

16. (Amended) A method according to Claim 12 ~~15~~, comprising the steps of:

providing a source of pumping radiation for the Nd:YAG sample; and

stimulating the Nd:YAG sample with the pumping radiation to cause the Nd:YAG sample to emit radiation having a wavelength of about 1μm.

19. (Amended) A method according to Claim 12, further comprising the steps of:

providing a second pair of members, at least one of which is substantially reflective to radiation having a wavelength of about 2μm; and

interposing the ~~solid-state~~ Tm:YAG sample substantially between the second pair of members.

20. (Amended) A method according to Claim 19, further comprising the step of locating the second pair of members substantially within the resonant cavity~~source of radiation having a wavelength of about 1μm~~.